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Knowledge Reuse Factors in the Innovation Process

INFORMS 2002

Ann Majchrzak
University of Southern California
amajchrz@marshall.usc.edu

Lynne Cooper
Jet Propulsion Laboratory
lynne.p.cooper@jpl.nasa.gov

Research Question

- What factors affect Knowledge Reuse for Radical Innovation (KRI)? Are the factors different than those used in Knowledge Reuse as Replication (KRR)?

KRR vs. KRI

- Knowledge reuse as replication (KRR)
  - Focus on replicating existing knowledge for a new group of users
  - Exploitation
  - Near transfer
  - Similar contexts
  - Problem to which knowledge applies is known
  - Knowledge "sources" can be identified
- Knowledge reuse for radical innovation (KRI)
  - Focus on creating new knowledge from existing knowledge
  - Exploration
  - Far transfer
  - Dissimilar contexts
  - Problem definition is evolving
  - Knowledge "sources" evolve

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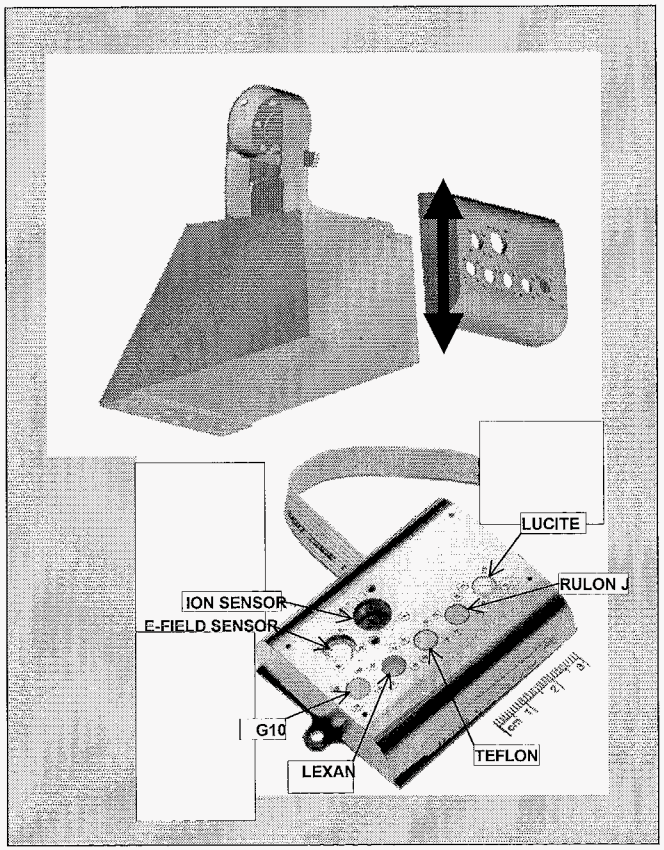
Research Design

- Inductive case study of KM episodes
- "Theoretical" sampling
  - Actual episodes of successful technical innovation
  - Innovation traceable and attributable to reuse of others' knowledge
  - Documents reviewed for 2 Mars instrument projects to identify 15 cases (episodes)
  - Arrayed cases from adopt to adapt (based on changes in form, fit, or function)
  - Selected 6; conducted interviews with key informants
  - Created timelines for each case and matrices across cases

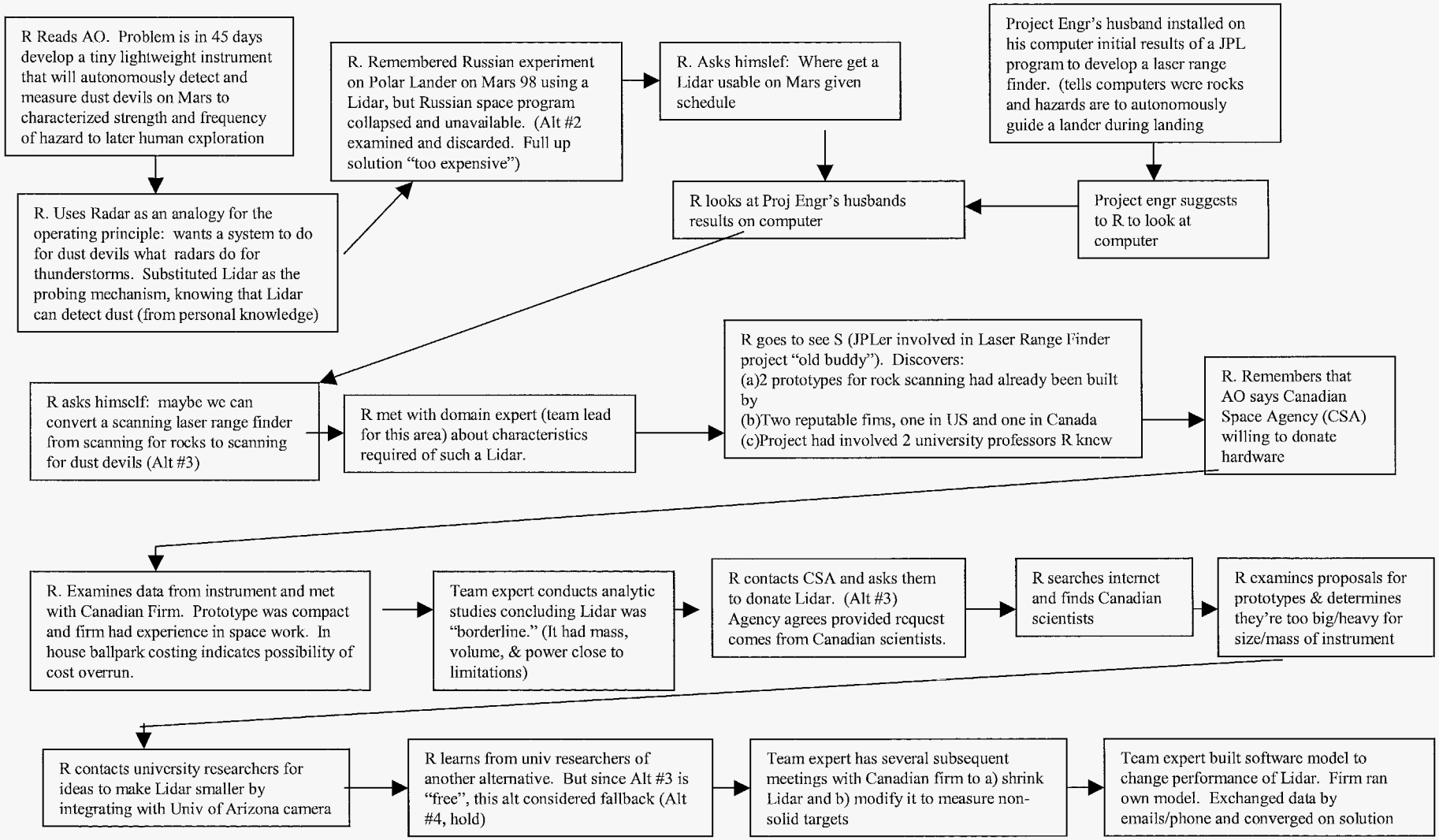
Reuse example: Electrometer

Before: separate measuring device, and material, single sensor, large size, and temperature requirements

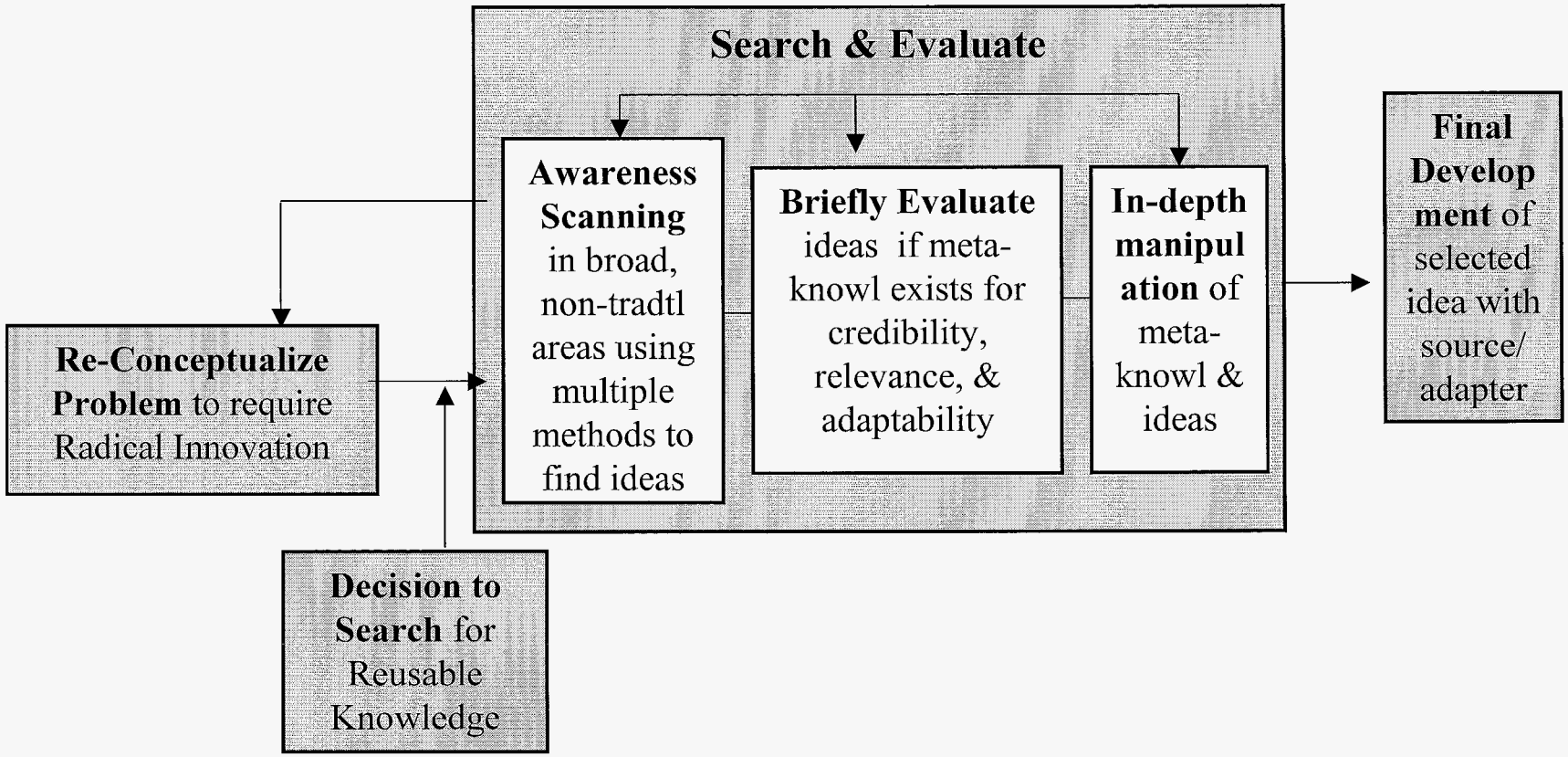
After: Integrated measuring device and material, half the size, multiple sensors, tolerant of extreme cold



LIDAR


R Reads AO. Problem is in 45 days develop a tiny lightweight instrument that will autonomously detect and measure dust devils on Mars to characterized strength and frequency of hazard to later human exploration
R. Uses Radar as an analogy for the operating principle: wants a system to do for dust devils what radars do for thunderstorms. Substituted Lidar as the probing mechanism, knowing that Lidar can detect dust (from personal knowledge)
R. Remembered Russian experiment on Polar Lander on Mars 98 using a Lidar, but Russian space program collapsed and unavailable. (Alt #2 examined and discarded. Full up solution "too expensive")
R. Asks himslef: Where get a Lidar usable on Mars given schedule
Project Engr's husband installed on his computer initial results of a JPL program to develop a laser range finder. (tells computers were rocks and hazards are to autonomously guide a lander during landing
Project engr suggests to R to look at computer
R looks at Proj Engr's husbands results on computer
R asks himself: maybe we can convert a scanning laser range finder from scanning for rocks to scanning for dust devils (Alt #3)
R met with domain expert (team lead for this area) about characteristics required of such a Lidar.
R goes to see S (JPLer involved in Laser Range Finder project "old buddy"). Discovers:
(a)2 prototypes for rock scanning had already been built by
(b)Two reputable fims, one in US and one in Canada
(c)Project had involved 2 university professors R knew
R. Remembers that AO says Canadian Space Agency (CSA) willing to donate hardware
R. Examines data from instrument and met with Canadian Firm. Prototype was compact and firm had experience in space work. In house ballpark costing indicates possibility of cost overrun.
Team expert conducts analytic studies concluding Lidar was "borderline." (It had mass, volume, & power close to limitations)
R contacts CSA and asks them to donate Lidar. (Alt #3) Agency agrees provided request comes from Canadian scientists.
R searches internet and finds Canadian scientists
R examines proposals for prototypes & determines they're too big/heavy for size/mass of instrument
R contacts university researchers for ideas to make Lidar smaller by integrating with Univ of Arizona camera
R learns from univ researchers of another alternative. But since Alt #3 is "free", this alt considered fallback (Alt #4, hold)
Team expert has several subsequent meetings with Canadian firm to a) shrink Lidar and b) modify it to measure non-solid targets
Team expert built software model to change performance of Lidar. Firm ran own model. Exchanged data by emails/phone and converged on solution

Knowledge Reuse for Innovation Process



(Majchrzak, Cooper, & Neece, in review)

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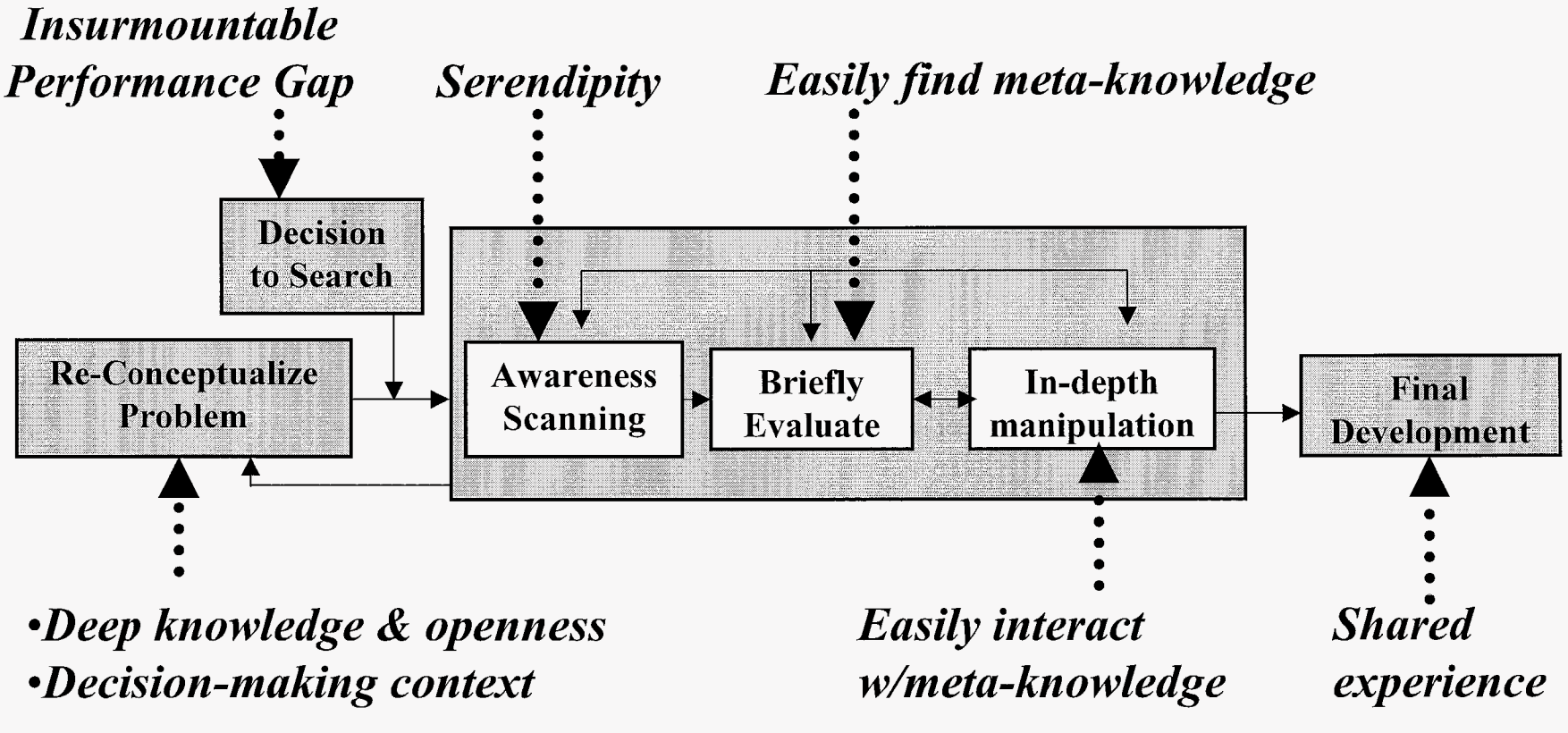
Innovator Behavior

- Iterate through stages
- Define problems to require innovation
- Decide to search
- Layer their search & evaluation
- Look for adapters
- Share knowledge thru co-development

(Majchrzak, Cooper, & Neece, in review)

Factors Affecting Knowledge Reuse for Innovation



Re-conceptualize Problem

- Characteristics of the individual
  - Deep knowledge: science goals, technology, inventing, ability to draw analogies
  - Openness: willing to consider non-traditional approaches and sources of knowledge
- Decision-making context
  - Competitive environment
  - Overall acceptable project risk

Decision to Search

- Insurmountable Performance Gap
  - Resulting from severe time and/or cost constraints
  - Admit they could not invent own solution and therefore considered reuse of others' knowledge

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Awareness Scanning

- Identifying ideas with potential relevance to conceptual approach
  - Broader searches in non-traditional areas
  - Did not fit immediate form/fit/function
- Used wide variety of search methods
  - Internet, face-to-face visits, strong and weak ties
- Serendipity
  - Capitalizing on unexpected good-fortune due to a chance occurrence

Briefly Evaluate

- Rapid assessment of credibility, relevance, and adaptability
- *Existence* of meta-knowledge
  - E.g., Data, models, prototypes, contextual cues, availability of a source or third-party adaptor
  - Used to infer credibility, relevance, and potential for adaptation

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In-Depth Analysis

- Determine if any of the ideas being considered could be adapted to meet the problem as formulated
- Meta-knowledge accessed, manipulated
  - Test ideas against the constraints and challenges of the model
  - Often involved hands on experimentation and extension

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Full Development

- Shift from "is it feasible" to "make it work"
- Shared experience with sources and/or adaptors
  - Transfer of best practices (for less innovative solutions)
  - Co-development (for more innovative solutions)

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Implications

- Three levels of search
  - Organizing knowledge resources for multi-level access
- Role of Meta-Knowledge
  - Describes the contexts, credibility of source, etc
  - Used differently (existence, access, manipulation)
  - Couple ideas with meta-K, organized around evaluation needs
  - Act as "chauffer" and "boundary object"
- Role of adapters
  - Absence of credible adaptors, or way to determine if adaptors are credible/available can create barrier to reuse
- Role of Project-level decisions
  - Cumulative risk
  - Can't look at reuse as isolated incidents

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Practical Implications

- Encourage innovators to be open to non-traditional approaches, search in non-traditional areas, & use multiple search methods; consider "opportunity-recognizers"
- Structure ideas in knowledge bases to encourage self-chauffeuring through 3 layers with cues for existence of meta-knowledge
- Find people willing to be idea-adapters
- Increase awareness of insurmountable performance gaps with invention